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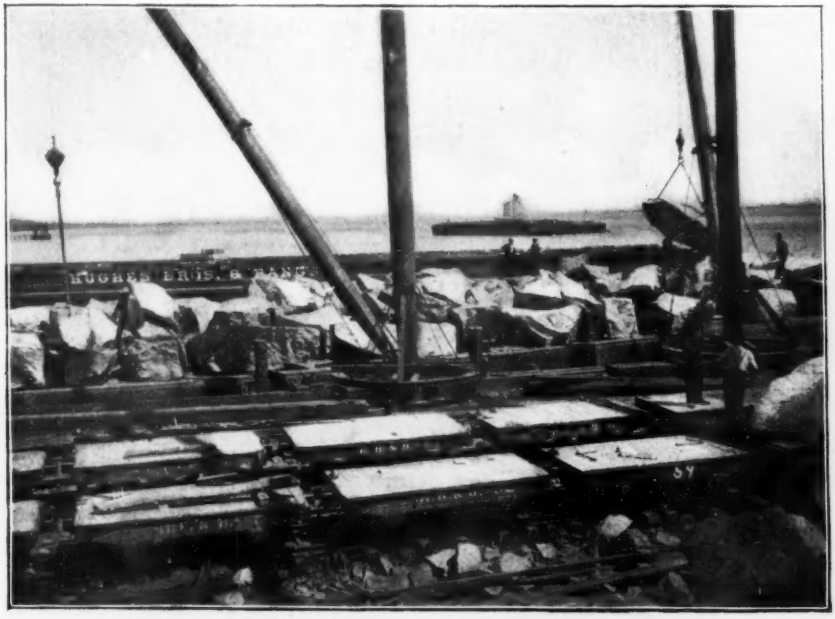
Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. II. NEW YORK, NOVEMBER, 1897. No. 9



THE USE OF COMPRESSED AIR IN BUILDING THE DELAWARE BREAKWATER.—See page 325.

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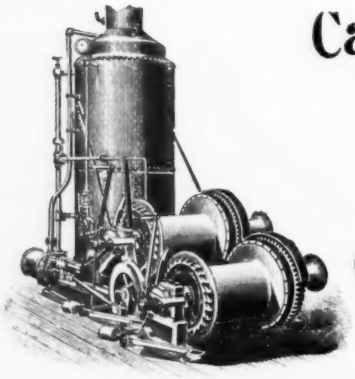

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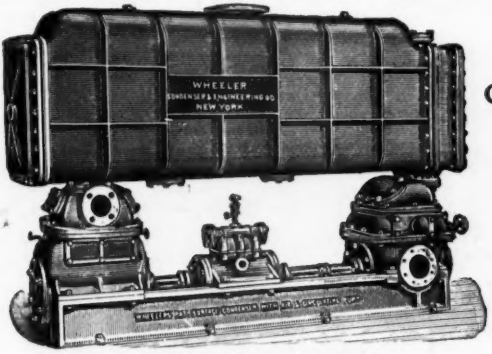

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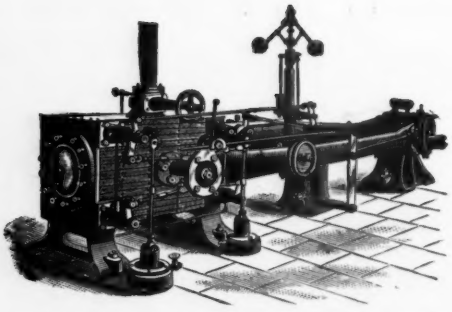

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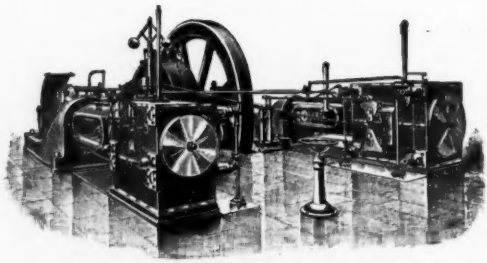

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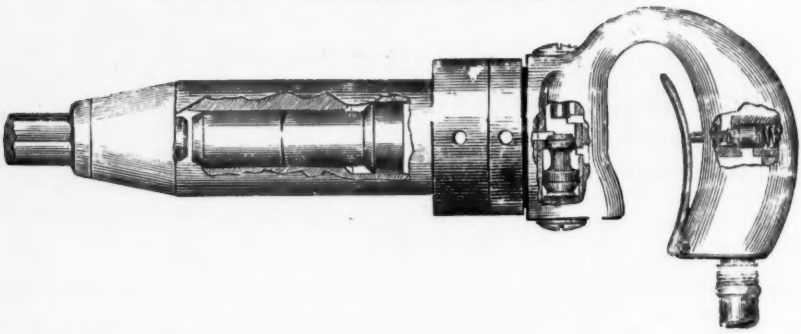

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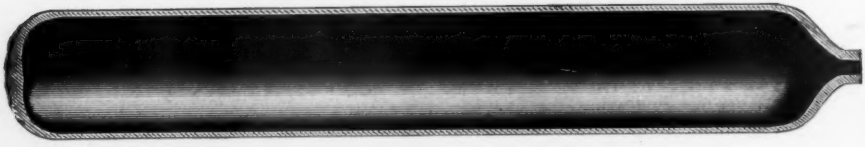

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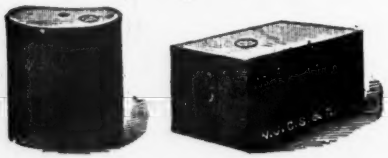

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A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Publisher
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J. E. QUINTERO, - - - - Treasurer

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Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 92 & 93 Fleet Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. II. NOVEMBER, 1897. NO. 9.

The "Engineering News" of November 4th contained a clear and valuable review of the two tests made on a four stage Ingersoll-Sergeant Air Compressor by seniors of Cornell University and Stevens Institute, the tests in detail having been published in the "Engineering News" on October 7th. The method of computing the efficiency of the Air Compressor defined as "the ratio of the useful work done by the air cylinders to the indicated work of steam cylinders," is interesting and as nearly correct, perhaps, as can be reached under the circumstances. It must be admitted, however, that the work done in the steam cylinders of this compressor was really more than the figures show, as it is stated in the beginning of the "Engineering News'" article that "the useful work done by the air cylinders was the storing in a receiver of 925 cu. ft. of air at a gauge pressure of 170 atmospheres." In order to do this, the supply pipe and the high pressure air cylinder were also filled with air at the same pressure. The second intermediate cylinder was filled with air at 780 lbs. pressure; the first intermediate was filled at 160 lbs., and the low pressure or initial cylinder at 55 lbs. In addition to these, the air was forced through the different coolers It is evident that this represents work done, and that it should be taken into account when figuring the efficiency of the compressor. Each cubic foot of internal contents of conveying pipe required 1,500,000 foot pounds of work at 170 atmospheres. It is practically impossible to follow the air through the four stages of compression and the intercooling between each stage, comparing and computing the effects of each operation successively and obtaining definite results. The efficiency shown in the "Engineering News'" article is certainly as good as could have been expected, and it is probably better than has ever been shown before for such high pressures. In making theoretical deductions from a test of this kind, the indicated horse power of the steam cylinders at the beginning of the series and the volume pressure and temperature of the compressed air at the other end are safe lines on which to base efficiency.

It is to be regretted that this test is not conclusive and that the Air Compressor was not operated under the conditions of actual service. The filling of a receiver from atmospheric pressure up to any other pressure, however high, is not what a compressor is built for. It has usually to maintain a constant high pressure in a receiver while the air is being drawn off and used at that high pressure. The first operation is one of compression pure and simple, while the second involves not only compression but delivery of the air, which is a very different thing. The first operation, which is all that is represented in these tests, merely brings the compressor to a point where it is ready to begin its legitimate work, and does not show its actual efficiency when at its proper work. It would not, therefore, be quite fair or proper to allow the statement of efficiency here obtained to go out as showing the actual efficiency of the compressor.

The results of our computations of the efficiency of the compressor in filling the storage receiver only are practically identical with those given in the "Engineering News." In the first case—the test made by Cornell students—the steam cylinders developed 1,556,280,000 foot pounds; and 694 cu. ft. of air, at a pressure of 171 atmospheres, was compressed from atmospheric pressure. The formula for the mean effective pressure, absolute, in compressing air isothermally from any given pressure to any other pressure, we use in this form:

$$\frac{(\text{Hyp. log } R) \times P}{R-1}$$

R being the ratio of the terminal to the initial pressure, and P the absolute terminal pressure in pounds per square inch. Substituting the figures we have

$$\frac{5.141663 \times 2513.7}{170} = 76.0268$$

The mean gauge pressure then will be

$$76.0268 - 14.7 = 61.3268, \text{ or say } 61.3$$

The power required for the compression will then be

$694 \times 144 \times 61.3 \times 170 = 1,041,433,056$ foot lbs., and $1,041,433,056 \div 1,556,280,000 =$ 66.91 per cent. as the ratio of the work done to the power expended, or the actual efficiency.

In the tests made by the Stevens Institute students, one-third more storage capacity was employed, and in the first test the work done was therefore 1,041,433,056 (as above) $\times 1\frac{1}{3} = 1,388,577,408$ foot lbs. The power developed by the steam cylinders being 2,029,500,000, we have $1,388,577,408 \div 2,029,500,000 = 68.40$ per cent.

In the second test by the Stevens Institute students, the final volume and the total work done was the same as in their first test, with the exception that at the beginning of the second test the receiver was already filled with air compressed to 136 atmospheres, and the work of this preliminary compression is to be computed and deducted. The hyp. log. for 13.6 being 4.912655, and $136 \times 14.7 = 1999.2$ pounds, the absolute pressure, we use these in the formula above and we have

$$\frac{4.912655 \times 1999.2}{135} = 72.75.$$ Then $72.75 - 14.7 = 58.05$ the m. e. p. Then $925 \times 144 \times 58.05 \times 135 = 1,043,855,100$ foot pounds, and $1,388,577,408 - 1,043,855,100 = 344,722,308$ foot pounds, the work actually done. As the power developed by the steam cylinders was 527,710,000, that is to be used as a divisor, as in the preceding cases, so $344,722,308 \div 527,710,000 = 65.32$ per cent.

This is practically a recapitulation of the "Engineering News'" figuring, but it represents independent computation all through. The results differ only as the work of any one computor may differ from that of another on account of difference of practice in the retention of the decimals. It confirms in every particular the results arrived at.

A quite simple means of ascertaining the ultimate efficiency of the compressor, at any particular moment of its operation, would have been to take a simultaneous set of indicator diagrams, as was done repeatedly by the students, and note at the same time the temperature and pressure of the air delivered. The steam cylinder cards would of course show the power developed, and from the card of the first or low pressure air cylinder the volume of free air taken in could be ascertained. It would not be necessary to pay any attention to the work of the other air cylinders. The temperature and pressure at delivery would supply all additional data required, so far as the mere computation of the efficiency was concerned. The card from the high pressure cylinder could not be expected to be minutely accurate, on account of the small area of the piston and the friction and other interfering conditions. The entire set of cards is of course valuable, and especially suggestive and instructive to the compressor designer as showing the relative economy of each stage of the operation and the interdependency of the different parts of the apparatus.

Abstract of Thesis Test of Compressed Air Power Plant at Jerome Park, N. Y.

By GEORGE W VREELAND and CHARLES M. YOUNGLOVE

To receive the degree of Mechanical Engineer at Cornell University the above named gentlemen sought to satisfy the requirement for a graduation thesis by making an exhaustive test on the Compressed Air Power Plant at Jerome Park, N. Y.

The purpose of the test was to determine the various efficiencies of a central power plant of this kind and point out any line of improvement that may be necessary.

A complete description of the plant was given in COMPRESSED AIR, No. 7, Vol. I., and it will not be necessary here to go into details further than say that the plant consists of 2 Hogan boilers with an aggregate of 540 H. P., and one Ingersoll-Sergeant Corliss Cross-Compound Condensing Air Compressor, the equivalent of 3400 cubic feet free air per minute at a pressure of 80 lbs.

The use to which compressed air is put to at Jerome Park represents a departure from old methods. Although the relative advantages are pretty well understood by those interested, any reliable information on any part of the plant is of importance, and great care was therefore taken in this test to give exact conditions.

We show samples of indicator cards taken from all cylinders of the compressor, and give the following abstracts, which no doubt will interest our readers.

A—Report of boiler test.
B—Engine data and results.
C—Compressor data and results.

REPORT OF BOILER TEST.

Duration of trial, hours, 10.

Dimensions.

Grate surface	Sq. ft.,	121
Water heating surface	"	5548
Superheating surface	"	None
Area for draft (Calorimeter)	"	
Area, chimney	"	19.73
Height, chimney	Ft.,	93
Ratio heating surface to grate surface		45.8 : 1
Ratio air space to grate surface		

Pressure.

Barometer	Inches, Merc'y,	29.76
Steam gauge	Pounds,	116.5
Absolute steam pressure	Pounds,	131.14

Temperature.

External air	Deg., Fah.,	65
Boiler room	"	79
Flue	"	483.5
Furnace	"	1918.
Feed water	"	105.8
Steam	"	259.05

Fuel

Total coal consumed	Lbs,	9284
Moisture in coal	Per cent,	2.22
Dry coal consumed	Lbs.,	9078
Total refuse, dry	"	1102
Total refuse, dry	Per cent.,	12.1
Total combustible	Lbs.,	7976

Fuel per Hour.

Dry coal, per hour	Lbs.,	928.4
Combustible, per hour	"	797.6
Dry coal per sq. ft. of grate	"	7.67
Combustible per sq. ft. of grate	"	6.59
Quality of steam	Per cent.,	97.9

Total Water.

Total weight water used	Lbs.,	84,510
Total evaporated, dry steam	Lbs.,	82,735
Factor of evaporation		1.154
Total from and at 212°	Lbs.,	95,476

Water per Hour.

Amount used,	Lbs.,	8451
Evaporated dry steam	"	8273
Evaporated from and at 212°	Lbs.,	9547

Economic Evaporation

Per pound of fuel.

Actual per pound, dry coal	Lbs.,	9.11
Equivalent from and at 212° (dry coal)	Lbs.,	10.51

Per pound of Combustible

Actual	Lbs.,	10.37
Equivalent from and at 212°	"	11.95

Per sq. ft. Heating Surface per hour.

Actual	Lbs.,	14.9
Equivalent from and at 212°	"	17.19

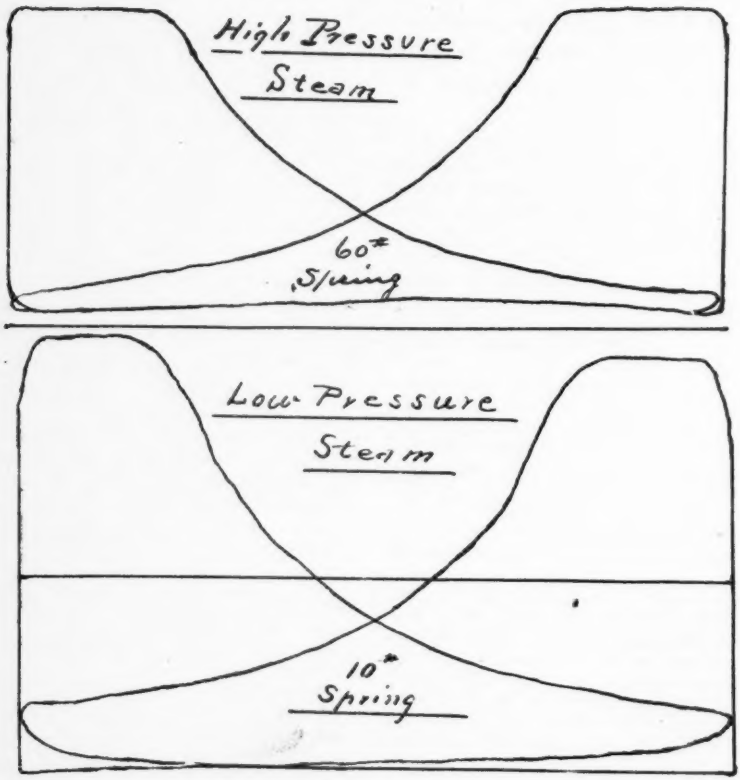
From 100° Fah. to 70 lbs. by Gauge.

Per pound of fuel	Lbs.,	8 57
Per pound of combustible	"	9.5

Evaporation per Hour.

Per sq. ft. of Grate.

Actual from feed water tem-



INDICATOR CARDS FROM CORLISS COMPOUND AIR COMPRESSOR AT JEROME PARK, N. Y., TAKEN APRIL 6TH, 1897.

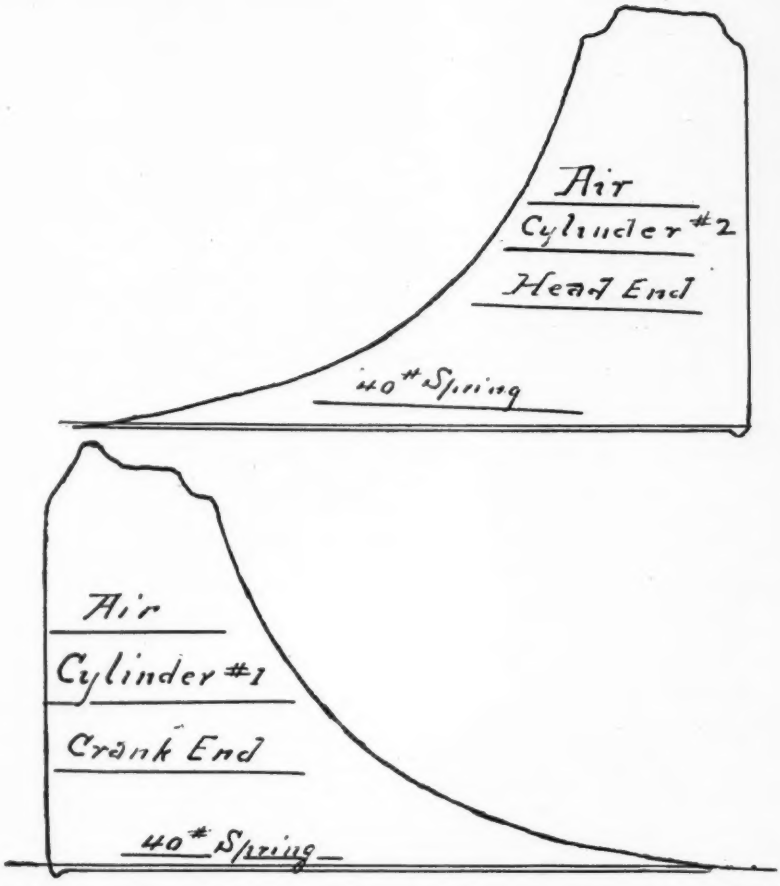
perature	Lbs.,	68.37
Equivalent from and at 212°...	"	78.89
Per sq. ft. of Water-Heating Surface.		
Actual	Lbs.,	1.49
Equivalent from and at 212°...	"	1.71
Horse Power.		
On basis 34½ lbs. equiv. evap. per hour (1)	H. P.,	277
Builder's rating	H. P.,	510
Ratio of commercial to builder's rating		50.5%
Heat generated per hour	B. T. U.,	11465740
Heat absorbed per h'r	"	8960200
Heat lost per hour	"	2505540
Efficiency of boiler	Per cent.,	78.1
Efficiency of furnace	"	78

(1) Standard Commercial H. P.

ENGINE DATA AND RESULTS.

Kind of engine, Cross Compound.

Duration of run	10 hours.
Revolutions per minute	57.06
Diameter of fly-wheel	22′
Weight of fly-wheel	50,201 lbs.
Temperature engine room	78
Temperature external air	65
Temperature condensing water, cold	74.3
Temperature cond'g water, hot	113.8
Temperature boiling point (atmospheric pressure)	211.7
Boiler pressure, gauge	116.5
Boiler pressure, absolute	131.03
Barometer in mercury	29.73
Barometer pressure in lbs	14.58
Condenser in mercury	23.3
Condenser pressure in lbs	11.04



INDICATOR CARDS FROM CORLISS COMPOUND AIR COMPRESSOR AT JEROME PARK, N. Y., TAKEN APRIL 6TH, 1897.

Total condensing water per hour.....Lbs.,	160360.
Weight condensing water per pound steam.....	19.7
Total I. H. P.	467.7
Total D H. P.....	402.4
Mechanical efficiency.....	86.03%
Moisture in steam.....	2.1%
Steam per I. H. P. per hour, actual.....	17 36
Steam per I. H. P., corrected for Cal.....	17.01
Water rate of perfect engine..	12.4
Thermodynamic efficiency.....	23.4
Ratio actual to theoretical water consumption	1.37

Heat supplied per hour, B.T.U.,	9634245.8
Heat discharged and radiation.... .. ..B. T. U.,	8456808.8
Heat utilized ..... "	1177437.0

	High.	Low.
Diam. of cylinder in inches.	24	44
Length of stroke.....	48	48
Diam. of piston rod, front..	4	5
Diam. of piston rod, back..	3⅝	3⅝
Piston displacement, crank end.....Cu. ft..	12.211	41.64
Piston displacement, head end.....Cu. ft..	12.221	41.92
Volume of clearance, head end .....Per cent..	3½	4

Volume of clearance, crank end	Per cent.	3½ 4
Make of Indicator	Thompson.	Tabor.
Scale of spring	60	10
Cut-off, crank end, % stroke	24.82	16.83
Cut-off, head end, % stroke	22.14	16.32
Release, crank end, % stroke	100	100
Release, head end, % stroke	100	100
Compression, crank end, % stroke	100	100
Compression, head end, % stroke	100	100
Absolute pressure at point cut-off, crank	120.58	26.23
Absolute pressure at point cut-off, head	119.98	25.53
Absolute pressure at release crank	27.63	4.16
Absolute pressure at release cut-off, head	26.58	3.99
I. H. P., head	123.3	104.74
I. H. P., crank	127.44	112.24
Total I. H. P.	250.74	216.98
Steam per I. H. P. at point of cut-off, per diagram, high pressure cylinder		11.3
Steam per I. H. P. at point of cut-off, per diagram, low pressure cylinder		7.25

COMPRESSOR DATA AND RESULTS.

	No. 1.	No. 2.
No. of cylinders, double-acting	1	1
Length of stroke, in inches.	48	48
Diameter of piston	24¼	24¼
Piston area, head, sq. in's	429.28	429.28
Piston area, crank, sq. in's	451.49	451.49
Diameter piston rod, in inches	3⅝	3⅝
Diameter piston air inlet, inches	6 7-16	6 7-16
Piston displac't per stroke, in cu. ft., head	11.924	11.924
Piston displac't per stroke, in cu. ft., crank	12.54	12.54
Clearance, head, % volume	.289	.289
Clearance, crank, % volume.	.287	.287
Displac't of piston, cu. ft., per minute	1395.68	1395.68
Developed H. P., mean	198.9	204.5
Absolute pressure at end of compression	80.76	82.20
Heat equivalent of work, steam end, per hour	1177437	
Heat equivalent of work, compressor, per hour	1023910	
Efficiency of mechanism, %	86.03	
Work of compression per lb. air, in ft. lbs., Adia	7658.53	
Work of compression per lb. air, in ft. lbs., Isoth	6286 44	
Efficiency of compression	82.05	
Combined effic'cy, 86.03 × 82.05	70.58%	

HEAT ACCOUNTS.

	No. 1.	No. 2.
Temp. of air at inlet	78	78
Temp. of air at exhaust	354.7	360.03
Rise of temp. of air	276.7	282.03
Temp. of entering jacket water	46.05	46.05
Temp. of exit jacket water	95.7	92.03
Rise of temp. of jacket water	49.65	45.98
Weight of jacket water per hour	2934. 6	2934.6
Heat rejected in jacket water (B.T.U., per h'r)	145705.	134935.
Heat rejected air leaving cylinder (B T U., per hour)	308063	313865
Radiation and unaccounted for	13701	18669
Total heat loss	467469	467469
Heat produced in compression	467469	467469
Calculated volume of air delivered in cu. ft. per stroke at atmos. pressure, allowing for clearance and by pass	12.11	12.11
Per minute, cu. ft.	1395.68	1395.68
Per hour, cu. ft.	83740	83740
Rated capacity of compressor at 60 revolut'ns per minute, in cu. ft. of free air	1467	1467
Per cent. of rated capacity delivered	95%	95%
Weight of comp. air per hour	12393.6	
Weight of comp. air per D H. P.	.517	
Volume of air delivered per 1 H. P. per hour at atmospheric pressure, in cu. ft.	358 09	
Volume of air delivered per D. H. P. per hour at atmospheric pressure, in cu. ft.	416.2	
Weight of water in cooling 1 lb. of air, in lbs.	.31	

In accounting for mechanical efficiency of 86.03 %, allowance must be made for the work of the jet condenser, which is attached by means of bell crank and connecting rod to crank pin of low pressure

engine—pumping about 200,000 pounds of water per hour with a suction of 5 feet, and also from a varying load as well as the condition of condensing water which enters condenser at a high temperature. This is occasional by a limited supply. The water being used over and over again, does not have time to cool, thus reducing the vacuum and decreasing the mechanical efficiency and increasing the steam consumption per H. P. per hour.

The Use of Compressed Air in Building the Delaware Breakwater.

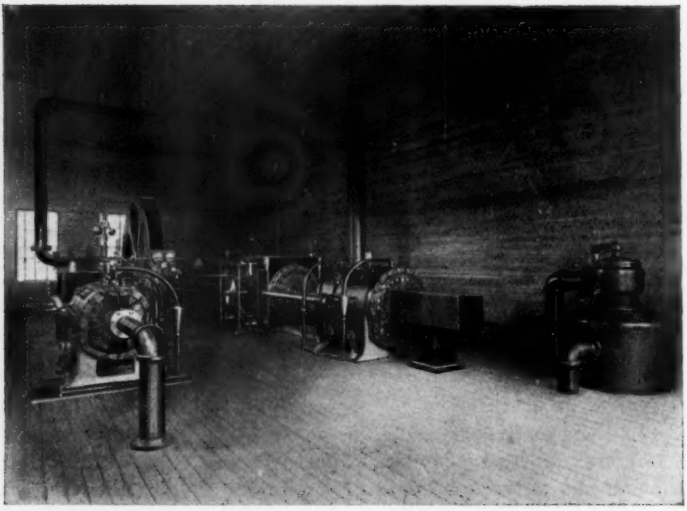
F. C. WEBER.

Among recent appropriations made for river and harbor improvements by the U. S. Government was an appropriation of $4,665,000, which provided for the construction of a harbor of refuge for deep draft vessels in Delaware Bay, and is expected to be completed on or before Dec. 31, 1901.

GENERAL PROJECT.

The plans submitted by the chief of engineers, January 29, 1892, which were adopted by Congress in the Act of June 3, 1896, are contained in the report of a commission of engineer officers, dated January 5, 1892, and published in Document No. 112, House of Representatives, 52d Congress, 1st Session. They provide for the construction of a stone breakwater located upon the line of least depth along the eastern branch of the shoals known as the Shears. This shoal is situated upon the west side of the main ship channel near

NO. 2.—MCMYLER DERRICKS.



No. 3. Air Compressor.

the entrance of Delaware Bay. It is proposed to form the breakwater by the deposit of random stone to the level of low water, and by the construction of a superstructure thereon, by the erection of outer and inner walls of very heavy stones, the interior space to be filled with rubble.

The total length of the breakwater at the level of mean low water will be about 8,000 ft., but this length may be increased if found practicable without increasing the quantity of stone estimated for the construction of the work.

The depth at mean low water along the site of the work varies from 13′ to 53′, the average depth being 28′.

It was assumed that each cu. yd. of enrockment will contain 1.25 gross tons of stone. Upon this assumption, the approximate amount of stone to be quarried for the construction of the breakwater, expressed in tons of 2,000 lbs. each, is as follows:

Substructure	1,210,665
Superstructure	173,745
Total	1,384,410

The site of the proposed breakwater is about 2¼ miles north of the Delaware breakwater harbor, about 3 miles from the Government pier at Lower Delaware, and about 10 miles from Cape May.

The contract for the complete work was let on Dec. 10th, '96, to Messrs. Hughes Bros. & Bangs, of Syracuse, New York, and is one of a number of large contracts on public works now in hand by this firm.

The work of laying out a plant for this immense work was begun soon after the awarding of the contract, and at the present time the work is pretty well under way, the output at the present time being just about 50% of the proposed total capacity.

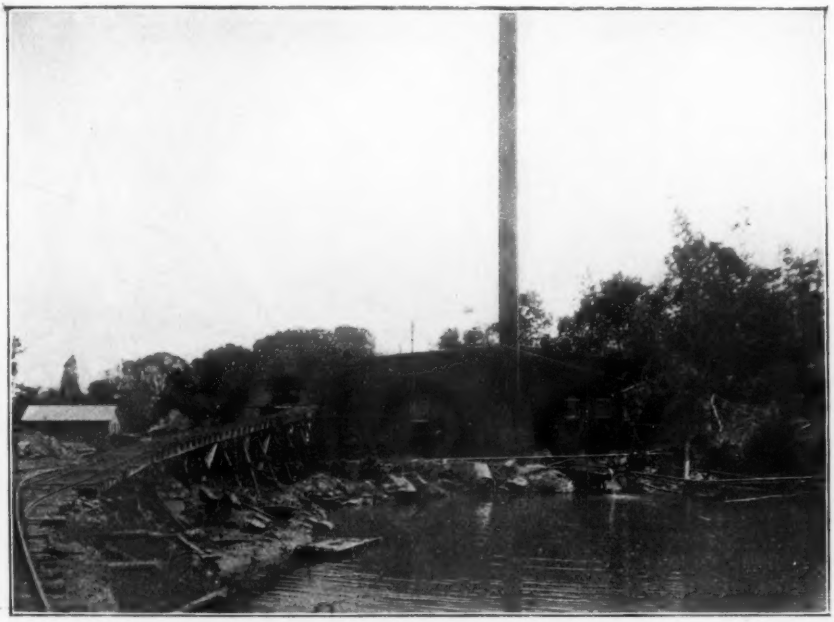
Suitable stone in sufficient quantity was found at Bellevue, Del., a station on the P. W. & B. R.R., and located on the Delaware river, about 5 miles from Wilmington, or a distance of 75 miles from breakwater. At this point a large dock has been constructed, and ample facilities are at hand for handling an output of 3,000 tons of stones per day.

Connecting the dock with the quarry is

one mile of double track railroad, built of 60-lb. steel rail, and has stone ballast laid on a 2% grade. A number of cross-overs, or sidings, are provided, so that loaded and empty trains may pass each other.

Four Baldwin locomotives (cut No. 7), with cylinders 12 x 16, handle the various mixed trains of flat cars and gondolas. The train equipment consists of 300 flat cars, 15 tons capacity, and 60 gondolas, 10 tons capacity each (for earth and small rock). consists of 13 barges, each 180 ft. long, with 40 ft. beam; 7 of these barges have flat decks and are fitted with steam derricks, and the other 6 are known as open bottom dump scows. The capacity of each barge is 1500 tons.

There are also 3 ocean tugs, 110 ft. long, that tow the barges from Bellevue to the breakwater, each tow consisting of 2 barges, and takes about 6 days to make the round trip.



No. 4.—Power House.

When a train load of stone reaches the dock it is run on one of the sidings, the locomotive taking back the empties, and two derricks, provided each with Bull wheels, as shown on cover, unload the stone from cars to the barges; 2 hoisting engines operate the derricks, and each Bull wheel is controlled by a small rotary engine operated by compressed air.

The water-way equipment for this plant

The quarry equipment proper consists of 9 McMyler Derricks; 20 Ingersoll-Sergeant Rock Drills, 3½″ cylinder; 12 Lidgerwood Hoisting Engines for operating 22 derricks, and several small pumps for draining quarry.

The McMyler derricks, as shown in cut No. 2, are fitted with steam cranes, run on 16 ft. gauge track, and have a capacity of 15 tons at 30 ft. radius, or 6 tons at 45 ft.

radius. The rock drills are of the standard Sergeant and Tappet make of the Ingersoll-Sergeant Drill Co.

The hoisting engines are 8¼" x 10" double cylinder, double drivers, so roped as to handle stones from 12 to 15 tons.

The question of operating so large a quarry plant as this in the most economical manner was thoroughly considered by the contractors. Estimates were received for electric transmission, compressed air and steam transmission. A visit to Jerome Park, where similar work is being done from a compressed air central plant, soon convinced the contractors that for work of such variable nature as this the Central Compressed Air Power Plant gave the best assurance of economy, and it was therefore installed.

The compressor is one of the best type made by the Ingersoll-Sergeant Drill Co., of New York, and has compound steam and air cylinders of the following dimensions:

High pressure steam cylinder			..	22" x 48"
Low	"	"	"	..40" x 48"
Low	"	air	"	..36¼" x 48"
High	"	"	"	..22¼" x 48"

The air cylinders are tied tandem to a Corliss Compound Condensing Engine, and are also connected by a vertical receiver intercooler, 48" diameter by 13' 6" high. (See cut No. 3). The air pressure is steadily maintained at 80 to 85 lbs. at

No. 5.—Coal-Bin 600 Tons Capacity, and Flat Deck Barge 1,500 Tons Capacity.

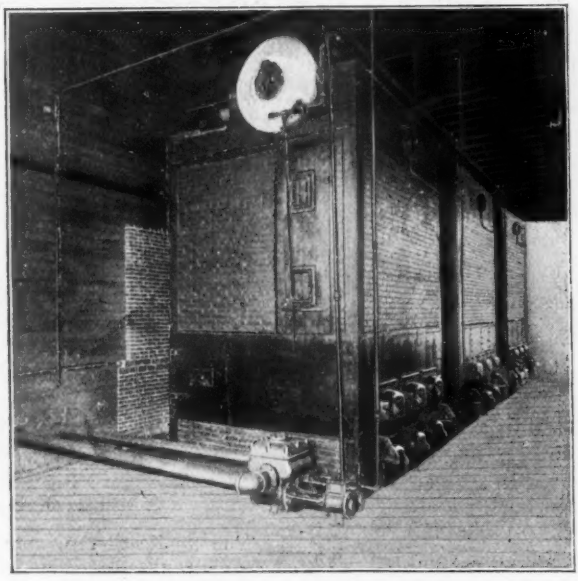
power house, and cut No. 4 shows location of power house. The pond shown in cut has an average depth of 14 ft., and is of sufficient area to maintain a low temperature for the condensing water which is used over and over. The coal is first stored in a 600 ton bin at the dock (cut No. 5), and carried as required by dump cars upon inclined track to bin of 300 ton capacity at boiler house (cut No. 4).

The boiler plant consists of 3 Hogan water tube boilers (cut No. 6) of 125 horse power each, and furnish steam to the compressor at 125 lbs. per sq. in.

One fireman is all that is required at the boilers, and the compressor receives the attention of only one man, the engineer; so that aside from the old method of carting the coal to the various small boilers about work of this kind, and the expense thereof, there is quite a saving effected in labor for attendance, to say nothing about the difference in producing a given amount of power by an economical Corliss engine, situated convenient for water and coal, as compared with a number of small boilers carrying steam through long, uncovered pipes, and where the boilers are constantly in danger of being damaged by flying stones, thus making the question of repair account an important one when compared with the central power plant.

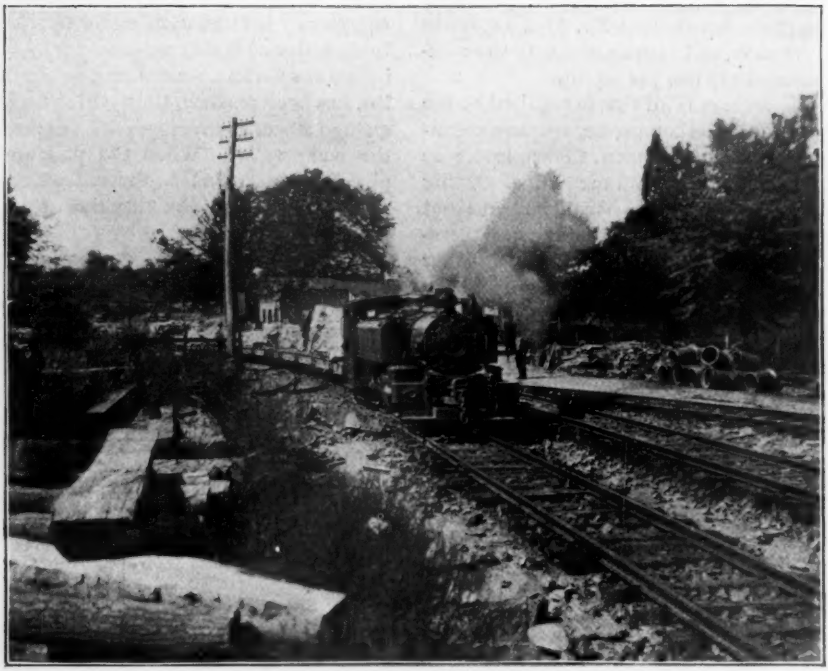
Aside from these questions of advantage, it will be well to bear in mind that the compressor is fitted with an automatic unloading device which unloads the air cylinders as soon as a maximum pressure of 85 lbs. has been reached, thus calling for only enough steam to overcome the friction of the compressor. When the pressure in pipe line falls to 80 lbs., the unloading device responds and the machine goes on with its regular work.

When rock drills use compressed air, the drill is capable of drilling more feet per day than with steam, due to higher pressure (because of no condensation), and the drills are easier handled by the operator on account of being cold. Again, a given quantity of oil will do more service in an air motor than in a steam motor, for there is less heat to destroy the useful effect.



No. 6.—Three Hogan Boilers.

The convenience of having air power on tap at this quarry is illustrated in its use in the various pumps which are set to



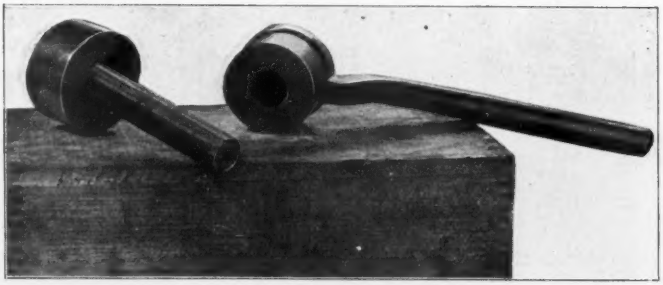
No. 7.—Loaded Train.

work intermittently and at any place without the delay of changing boilers and keeping them partially fired. Drinking water of the finest quality is drawn from a well 200 ft. deep, by means of a Pohle Air-lift Pump, a device calling for but 2 long pieces of pipe, and has no valves to get out of order.

Up to the present time there has been no trouble due to freezing of the moisture contained in the air. However, if trouble should arise from that source in winter, small reheaters will be placed near the various motors, which are quite inexpensive to maintain and have the good grace to add about 30% to the efficiency of the plant when used in the proper manner.

This is practically the second large plant of this kind in this country, and we venture to predict the establishment of more; for the results obtained are so far in advance of old practice, that it would be folly to go back.

The application of compressed air for mechanical purposes in Paris has developed to wonderful proportions. It is said that it now takes 24.000 horse power to operate all the appliances. These embrace printing presses, saws, pumps, grindstone lathes, sewing machines, tin-smith shears, ventilators, and enters into almost every industry. In 1892 they compressed 6,887 millions of cubic feet of air, with a system of 105 miles of compressed air pipe laid under the street, 41 miles of which is used for pneumatic clock service, and about 64 miles for other appliances.



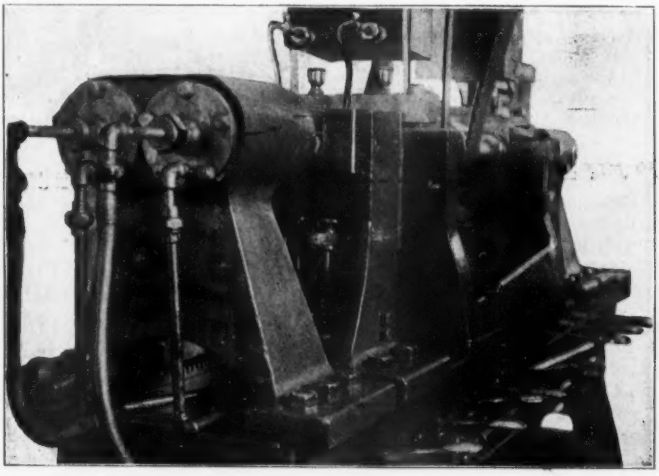
TOOL FOR SCREWING IN STAYBOLTS.

In the Shops.

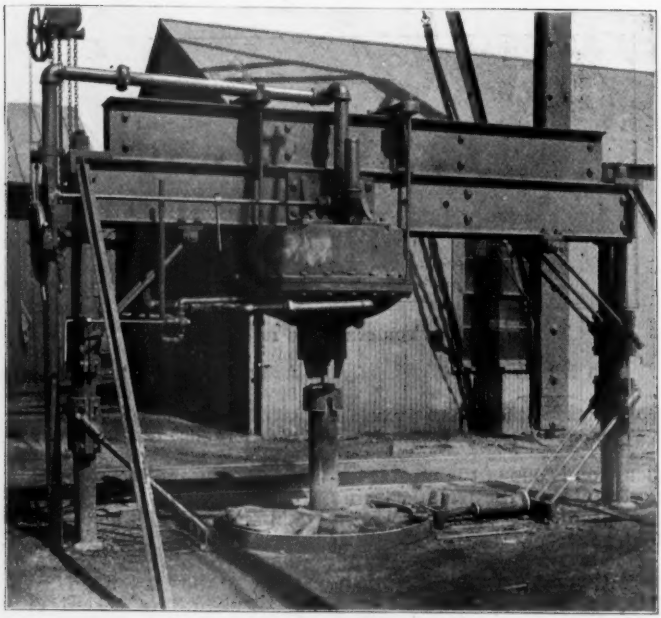
BOILER AND FIREBOX-SHEET AND STAYBOLT WORK AT THE UNION PACIFIC SHOPS.

The boiler shop is one of the most interesting departments of the manufacturing and repair plant of the Union Pacific at Omaha, and, as usual, the firebox work embraces some of the best features of this department. It is perhaps unnecessary to say that compressed air is used to a very great extent; With the air plant installed and in operation in such a variety of operations, it is difficult to imagine the possibility of a substitution of power or of accomplishing the work without its assistance with any degree of economy.

All firebox ends of boilers are made from sheets as large as can be obtained from the manufacturers; that is to say, sheets are never spliced when single sheets of sufficient size can be obtained. The largest now used are for the firebox boiler sheets, and the sizes are 109½ by 235½ inches and 114 by 176 inches for different classes of boilers. The work to be done is laid out on the flat sheets before bending, and the punching for staybolts, rivets, etc., is done upon the press shown in an accompanying illustration. The press is a home-made affair, located out of doors. It is built up of columns firmly anchored in the ground and braced, and the thrust is taken by heavy I-beams secured to the top of the columns. The "anvil" is a part of a driving axle supported by a driving wheel centre as a base. The opening between the uprights is about 12 feet. The sheets are handled during the punching process



STAYBOLT DRILLING MACHINE OPERATED BY AIR.



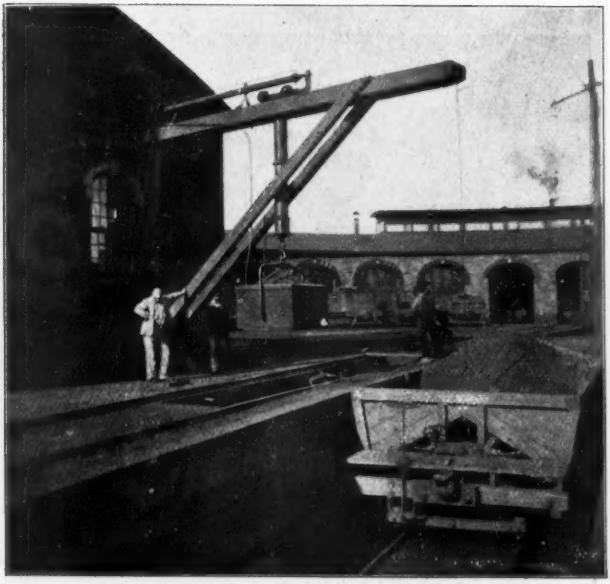
PUNCH FOR LARGE BOILER SHEETS.

by a crane, also partially shown in the illustration. This punch is operated wholly by air. After punching, the sheets are bent to shape in ordinary bending rolls.

An ingenious device is used for holding firebox ends while flanging. The bed consists of a thick cast-iron plate of the form which the inside of the sheet is to be after flanging. This is supported near the ground level of the shop Above this is a plate of similar shape, but smaller, which is attached to the piston of a long air cylinder anchored above. The sheet being laid upon this base, the upper plate is brought down and held by the air pressure while the flanging is done with hammers. The pressure is sufficient to hold the plate firmly in place, the base plate serves as a former to give an accurate curvature, and the piston rod being in the middle of the plate is entirely out of the way of the workmen.

The staybolt practice in this department is an especially interesting feature of the work. The holes are tapped by the use of an air-operated tool, and the staybolts are screwed in in the same manner. All staybolts are screwed in from the inside and cut off inside. To do away with the necessity of forming a square head upon each staybolt, an ingenious and simple tool has been devised. This is shown in two forms in one of the accompanying engravings, one in a form adapted for handwork and the other the chuck which is used with the air engines. The clutch consists simply of a disc having an opening to receive the end of a bolt eccentrically mounted upon a pin, which is cut away so as to form about one-fourth the wall of the opening. The pin forms the means of attachment to the engine or to the handle when used in hand work. It is clear that the turning of the pin in the disc will cause the edges of the part of the pin forming the walls of the opening to grip the bolt firmly between itself and the other wall of the opening, and the result is the same in whichever direction the tool is turned. It is said that the threads of the bolt are not injured by the use of the tool, and the saving of the work of forming a square end is an obvious economy.

It is the practice of the Union Pacific to drill all staybolts for 1½ inches from the outer end, as a precautionary measure to secure a sure indication of bolts partially broken near the outer sheet. The work is done before the bolts are inserted, contrary to the practice in many shops. This method



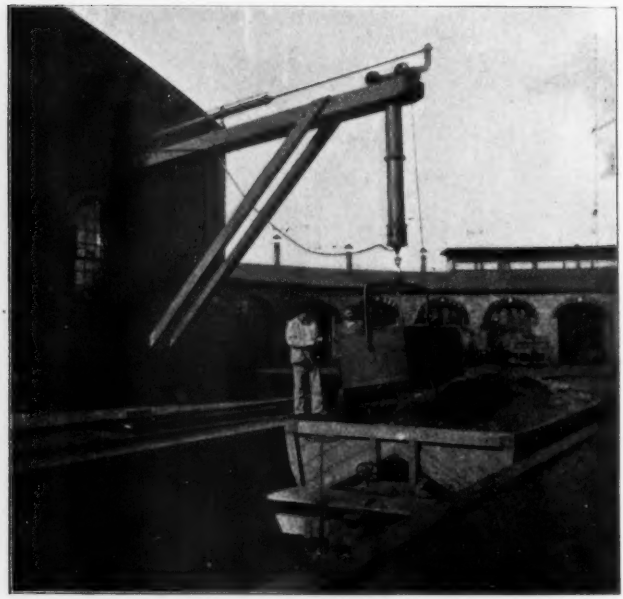
CINDER HOIST IN D. S. S. & A. RY.—FIG. I.

is made possible by the practice before mentioned of screwing in and cuting off staybolts on the inside of the firebox, since if it was necessary to cut them off outside, the drilled holes would be partially or wholly closed in the process of cutting. A special machine has been designed for the purpose of drilling, which is substantially automatic except in so far as it is necessary to turn air off and on. A general view of this machine is shown herewith. Both ends are the same as the one shown, the machine being fitted up double, though the work at present requires the work of one part of the machine and one man only The air is regulated by the handles at the front of the machine. In operation, the bolt to be drilled is automatically gripped and presented to the drill, withdrawn at intervals to clear the drill, while constantly fed at a uniform rate. When the gauge indicating the proper depth of hole is reached, the bolt is withdrawn from the drill and automatically released from the clutches. Each of the two cylinders shown represents a separate working part of the machine, three hand levers being necessary for controlling the operations of each cylinder. The rate of drilling is about 140 staybolts per hour, one man operating two drills.—Railway Age.

Cinder Hoist on the D. S. S. & A. R.R.

The accompanying illustrations from the *Railway Age*, show a cinder hoist that has been in successful operation on the Duluth South Shore & Atlantic Railway at Marquette for the past two years. It is operated by air and is estimated to be a money-saver to the extent of at least $600 a year. With this arrangement five iron buckets can be hoisted, dumped and replaced in the pit again on an average in 15 minutes, removing in the operations the same quantity of ashes as would take a man with a shovel at least three hours to handle. The ashes are raked from ashpans directly into the ash buckets, and the same is done with cinders in the front end, no shoveling being required. The act of hoisting and dumping is done by the engine hostler and his assistant.

A sunken track will be noticed located parallel with the cinder pit (the distance from centre of cinder pit to centre of this track being about 10 feet), on which is standing a cinder car, which was built especially for this service. One of our views shows the bucket containing the cinders hoisted out of the cinder pit; the other view shows the bucket dumped over the car. When not in use the crane is swung



CINDER HOIST ON D. S, S. & A. RY.—FIG 2.

around alongside the end of the roundhouse.

The hoisting cylinder is hung to a four-wheeled truck on top of the crane, the piston of the horizontal cylinder being attached to the truck. Air is admitted at either end of the horizontal cylinder alternately for pushing out the loaded bucket to the proper position for dumping and pulling it back after being dumped. Air is furnished from the shop air plant. When shops are not working, any engine having its fire cleaned can couple to an air hose coupling attached to the crane and perform the operation of hoisting and dumping the buckets.

The crane has a radius of about 30 feet, and by manipulating the horizontal cylinder properly the buckets may be dumped anywhere on a 32-foot car without moving the car until it is loaded. The old way of loading the cinders was to keep a man continually shoveling them out of the cinder pit into the car, at a cost on an average of $50 per month. Now the cost of getting rid of the cinders is practically nothing, as far as labor is concerned. The whole cost of the plant, including the five iron ash buckets, was $250.

Painting Buildings by Compressed Air.

The following interesting description, by Mr. J. J. Hubbell, is taken from the Michigan Engineers' Annual for 1897:

The buildings belong to the Buckley & Douglas Lumber Co., and included a main building 475 ft. long by 356 ft. wide. The structures covered about five acres, and there was fully 1,000 "squares," or 100,000 square ft. of surface to be covered with paint. Rough hemlock lumber was used in the sides of these buildings, and the problem was to cover this siding with some preservative compound as cheaply as possible. After a full consideration of various washes, a mixture of good raw linseed oil and red oxide of iron was determined on.

Bids were received from three local painters. One of these offered to furnish brushes and ladders and to apply the paint for 35 cents per square; another offered to do it for 28 cents if the company provided all material; and the third made a lump bid of $300 for providing labor alone. Each of these bids was reasonable, but all of the painters deemed two coats necessary, and thought the season too far ad-

vanced to undertake the work at the time. In this emergency Mr. Hubbell determined to use compressed air for the work.

He made his own sprayer at a cost of $10, and in addition provided 150 ft. of ¾-inch hose, an air pump taken from a locomotive, and an air reservoir also taken from a locomotive. This latter had a capacity of 10 cu. ft., and was placed near the large building and connected to the air pump by ½-inch gas pipe. He says that he should have used ¾-inch pipe, but the smaller pipe was on hand in quantities. Of the hose, 125 ft. were to connect the nozzle with the air reservoir, and 25 ft. to connect the nozzle with the paint bucket, the latter being elevated to about the level of the nozzle.

The paint came in barrels of 50 gallons each, and to each head of these barrels was screwed an iron flange with a short journal attached. The barrel was hung on these journals and revolved by a crank so as to thoroughly mix the paint, which was then drawn off by a molasses gate set in the side of the barrel, two or three gallons at a time. In use the air pressure ranged from 40 to 50 lbs., and as the air passed through the nozzle it sprayed the paint in a fine cloud looking like a jet of red vapor. The discharge was controlled by a valve in the base of the nozzle, and the operator soon became expert and could paint 8 or 10 ft. above his head and the same distance below his feet. Two men were required, one to keep the paint bucket full, and the other to handle the brush. There was little waste of paint, though every crevice was filled, and the rough surface was covered better than it could have been done by hand. One gallon of paint would cover about 150 sq. ft., and the two men would cover about 5,000 sq. ft. in one day. The windows were protected by a light movable canvas covered frame.

The cost of the oil paint thus applied did not exceed 10 cents per 100 sq. ft., and the cost of painting the buildings, including all labor and a reasonable sum for the use of the air pump, pipe, reservoir and brush, was less than 15 cents per square of 100 sq. ft., or less than one-half the cost of painting by hand.

The Cleaning of Carpets.

One of the complications peculiar to life in large cities is the difficulty that besets the householder when he desires to have his carpets cleaned. The old-fashioned way of shaking or beating them from windows is prohibited in most large cities, and the alternative of taking them to the fields is, for various reasons, cut off. Brushing will serve for a certain period, but in time a more effective treatment becomes imperative, and experience has long since shown that, unless the work is conducted with great care and method, the cleaning process may be as destructive as that of the Indian *dhobi* or washerman. The weight alone of many carpets renders the most careful handling necessary, and if the carpet be valuable as well as old, it may suffer serious deterioration in the process of cleaning. The original method of cleaning carpets was carried out with the aid of sticks handled by laborers, and lubricated with beer—for the job was a very thirsty one It was carried out in the nearest convenient field, and if there was any wind, the dust went with it; if not, the beaters were enveloped in a very unwholesome cloud. Sticks would occasionally go through the carpet, and it generally returned from cleaning a good deal the worse for wear. The first attempt at mechanical dry cleaning was made with a machine something like that used for beating rough cocoon silk waste after washing. Next, a fan was added to carry off the dust; then leather beaters superseded the sticks, and finally compressed air was employed in numerous fine streams, which without the least violence seems to drive out every particle of dust in any carpet, however dirty. A visit to the headquarters of the Patent Steam Carpet Cleaning Works at York Road, King's Cross, London, will enable those who are interested in the subject to see the process in operation.

The beating machine, by which the carpet is struck on the underside by revolving leather beaters, will take in carpets 54 ft. wide and of any length. They are passed forward and backward through the machine until they cease to give off any dust, all the dust being carried off by an exhausting fan and discharged into a chamber where it meets the exhaust steam from the engines. The effect of the steam as it condenses on the particles of dust is to increase the weight of the dust and cause it to fall to the ground. The workmen attending these machines pass their days in a clean atmosphere, the current passing them to enter the machine. The compressed air machine is the latest improvement which, as has already been

stated, dispenses altogether with beaters. A powerful pair of engines, capable of developing 200 horse power, is used to drive the air compressors which provide the air supply at a pressure of 70 lbs. per sq. in. The air escapes from a row of jets in a pipe striking the surface of the carpet and dislodging all the dirt. The cleaning machine itself is a very simple affair. The carpet is passed over a long cylindrical roller built like a cage. Above this cage, at a distance of about 2 inches, is suspended the jet pipe, parallel with the roller. The pipe has a short back-and-forward movement communicated by the engine, and the carpet passes slowly over the roller beneath the vibrating jets of air. An exhausting fan carries off all the dust and the air from the jets to a chamber where steam precipitates all the solid particles. The process is continued until when struck with a rod the carpet gives off no dust. In this manner the most valuable carpets may be cleansed without risk of injury to their texture.

The company have works at Manchester, Leeds, Dublin and Glasgow, as well as in London. This process has an interest which extends far beyond the business of carpet cleaning. It will doubtless find further application in the separation of dust and dirt from many materials, and it points to means for the reduction of the offensiveness and unwholesomeness of many trades which at present have to be segregated. There is a distinct relationship between the carpet cleaning process and the more recent one for cleaning railway carriages with an *air brush*, which works with extraordinary rapidity, and neither wears the linings nor rubs dirt into them, as is the case with the hair brush. Compressed air has, during the last few years, been recovering from a damaged reputation acquired through misuse. In many cases it was used at excessive pressures, at other times the pressure was too low. The methods of compressing it were also defective. It is now used successfully for a great variety of purposes, including the driving of underground machinery in mines, propelling tram cars, driving cranes and machine tools, rock boring in tunnels, pneumatic transport, cooling stores of perishable merchandise, etc. For the transmission of small powers in factories compressed air is most convenient. It needs no exhaust pipe and no covering on the conduits. Its efficiency is greatly augmented by being heated before use in motors, but the heat must be supplied immediately before use, as hot air cools very rapidly in pipes. —The Indian Textile Journal.

Consolidated Pneumatic Tool Co.

The Consolidated Pneumatic Tool Company, with offices at 1404 Bowling Green Building, New York, and shops at Frankford, Philadelphia, Pa., has been organized under the Laws of the State of New York, for the manufacture and sale of pneumatic stone cutting tools, pneumatic tools for calking boilers and chipping metals, air compressors, and complete compressed air equipment.

This company has purchased the entire business, patents, stock and manufacturing plant of the Wolstencroft Pneumatic Tool; and also all of the patents, special machinery and stock of the Keller Pneumatic Tool, together with the good-will of both businesses.

The Directors of the Company are as follows: O. W. Norcross, of Worcester, Mass.; John Evans, H. B. Torrey and George T. Hartford, of Boston, Mass.; Peter Gray, of Philadelphia, Pa.; George Cohen and W. P. Pressinger, of New York.

The officers are: Peter Gray, President; George Cohen, General Manager: John Evans, Treasurer; and W. P. Pressinger, Secretary.

In its announcement to the trade the company calls attention to the broad patent privileges of unquestionable validity which it owns, and to its unequaled facilities for the production of pneumatic tools of the most superior grade. The announcement further states that the company has placed upon the market a pneumatic tool combining every superior feature covered by its numerous patents, remarkable in its simplicity of design, entirely devoid of valves, washers, springs, or other complicated parts, to be known as the "Consolidated," and that the merit of this tool has been demonstrated by some of the most prominent marble and granite cutters in the trade, who have given it an unqualified endorsement as superior to any tool yet produced.

The announcement continues with the statement to the effect that the company proposes to inaugurate a new era in the pneumatic tool trade; its first steps in that direction will be to sell its tools at reasonable prices. In fact, the company flatly announces that its prices for tools are lower than any which have prevailed here-

tofore, and that its prices will be maintained as low as is consistent with the production of pneumatic tools of the highest grade of material and workmanship. The company hopes thus to increase the volume of its sales, and at the same time keep its selling expenses at a minimum.

In conclusion the announcement calls attention to the fact that the affairs of the company are managed by veterans in the trade, and that its policy will be one of sound, honorable business methods.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz: all communications should be written on one side of the paper only: they should be short and to the point.

OCEAN STEAMSHIP CO. OF SAVANNAH,
Office of the Vice-President
SAVANNAH, GA., Oct. 23, 1897.

Publisher, "Compressed Air."

I have had some correspondence with manufacturers of air compressors in the matter of machinery that could be operated by compressed air, for the purpose of, as they term it here, screwing cotton into the holds of the vessels.

No doubt you are aware that on foreign vessels the bales of cotton are placed in the vessels by means of two jack screws made especially for that purpose. There are five men required for each screw; four to turn the crank and a foreman.

I would respectfully suggest that some party of an inventive mind study this question, as I am positive that this work could be done with an air compressor far more satisfactorily, so far as the work and cost is concerned, than it is being done now.

There are a large number of vessels being loaded in the port of Savannah at the present time, and I would be very much pleased indeed to render any assistance that I could to acquaint any party or parties with conditions as they now exist. An early reply will oblige,

Yours very truly,
JOHN M. EGAN, Vice-Pres.

Death of Thomas Doane.

Thomas Doane of Charlestown, Mass., the well-known civil engineer, died October 22. He was born at Orleans, Cape Cod, in 1821, and after attending the Andover Academy he entered the office of Samuel L. Felton, a noted engineer. After remaining with him for three years he became engineer of a division of the Vermont Central Railroad. Mr. Doane was connected at one time and another with all the railroads running out of Boston. In 1863, he was appointed chief engineer of the Hoosac tunnel. He located the line of the tunnel and built the dam in the Deerfield River to furnish water power. In this work he introduced nitro-glicerine and electric blasting for the first time in this country. In February, 1875, he ran the first locomotive through the tunnel. In 1869 he went to Nebraska, and built 240 miles of railroad on the extension of the C. B. & Q. R. R. He made the question of grades a special study, and so perfect were those on the extension that one engine could haul as many cars to the Missouri River as five engines could haul across Iowa. When in Nebraska he took a leading part in the agitation of the question of establishing a college in that State, and in recognition of his services the institution was named Doane College.

The Clayton Air Compressor Works, Brooklyn, N. Y., offices, Havemeyer Building, 26 Cortlandt Street, New York, report that their volume of sales for the month of October is larger than any preceding month in the history of the business and three times greater than their average sales for five years past. These works are now constructing one twenty-five horse power compressor for thirty-five hundred pounds pressure and one fifty horse power compressor for twenty-five hundred pounds pressure, for the Western Manufacturing and Oil Company, Newark, N. J. They

also have orders in hand for a compound air compressor ordered by Fraser & Chalmers of Chicago, a duplex air compressor for the Deane Steam Pump Company, Holyoke, Mass., three duplex air compressors for compressed air shop plants, two air compressors for the Consolidated Pneumatic Tool Company, one air compressor for sand blast work, one for operating pneumatic railway signals, two compressors for air lift pumping plants, two compressors to the Shone Company of Chicago for their pneumatic sewerage system, and one large duplex compressor for the Consolidated Gas Company, New York. This unprecedented rush of business is a satisfactory demonstration that improved times are here and a most decided recognition of the merits of the Clayton air compressing machinery.

The Western Railway Equipment Company of St. Louis report having sold one hundred and eighty (180) of their Houston Track Sanders during the month of October to the following roads:

The Western Maryland, for two shops; Baltimore & Ohio, for two shops; New York, Ontario & Western, for two shops; Main Central, Texas & Pacific, St. Louis Southwestern, Denver Rio Grande, St. Joe & Grand Island; St. Louis, Chicago & St. Paul; Missouri Pacific, Seaboard Air Line, Baltimore, Ohio Southwestern, Pittsburg, Lisbon & Western, The Erie, Kansas City, Fort Scott & Memphis, Missouri, Kansas & Texas, St. Louis, Iron Mountain & Southern, Kansas City, Memphis & Birmingham, International & Great Northern; Atchison, Topeka & Santa Fe; Schenectady Locomotive Works, Baltimore Locomotive Works, Pittsburg Locomotive Works, Dickson Manufacturing Co.

PNEUMATIC APPLIANCES.

PATENTS GRANTED OCTOBER, 1897.

Specially prepared for COMPRESSED AIR from the Patent Office files by Grafton L. McGill.

590,686.—Pneumatic Motive Power. Louis H. Meyer, Philadelphia, Pa.

This invention comprises an endless tube, within which is provided a piston having disc heads, the periphery of which conform to the inner surface of the tube. The piston is caused to travel continuously within the tube by action of the exhaust of air from said tube, the movement of the disc-headed piston imparting action to gearing outside of the tube.

590,661.—Pneumatic Tool. Frank E. Hartham, Worcester, Mass.

This device is of the character known as percussion tools. It consists of a hammer cylinder, within which is held a sliding, tool-holding socket. An air passage leads from a source of air supply to the cylinder and is opened and closed by means of a neck in the socket forming an annuler chamber; the sliding movement of the socket bringing the air passage into alignment with the supply passage.

591,137.—Air or Gas Compressor. Stephen S. Miles, Cincinnati, Ohio.

A casing encloses a cylinder which has an open end or mouth projecting into the casing. The other end of the casing is provided with a flange which closes that end of the casing. Also on this end, and to the casing, is bolted a head. Said cylinder is wholly surrounded by an annular jacket-space between the former and the casing. Between the casing and the inner end of the cylinder is an annular rib or partition provided with a passage for communication between the jacket-space and the main interior portion of the casing. A pipe admits the return air to the annular jacket-space, thence around the cylinder, and through the casing by way of the passage in the annular partition. A central crank-shaft carries a plunger provided with inlet valves to the cylinder. The cylinder-heads are provided with exit valves, while pipes connect said exit valves to a condenser.

591,284.—Pneumatic Drill. James H. Manning, Omaha, Neb.

A casing or shell is provided with a plurality of cylinders. A crank-shaft is journaled in the casing and extends at its opposite ends therethrough. The pistons in the cylinders have their rods connected to the crank-shaft. A valve is mounted on the projecting upper end of the crank-shaft, within a valve-chamber at the upper end of the casing, which controls the ports leading to the outer ends of the cylinders. Fast on the lower projecting end of the crank-shaft is a pinion on the opposite side of the casing from the valve. A tool-holding shaft is journaled in a support upon the underside of the casing, beneath and in line with the lower projecting end of the crank-shaft. On the upper end of this shaft is a gear, while a spindle is journaled in a support at one side of and parallel with the lower end of the crank-shaft and upper end of the tool-holding shaft. Fast upon this spindle are a gear wheel and a pinion which mesh, respectively, with the pinion upon the lower end of the crank-shaft and the gear-wheel upon the upper end of the tool-holding shaft.

591,018.—Pneumatic Motor. George W. Smith, Topeka, Kans.

This invention is also of the class of drilling tools. It is a portable device and consists of a fluid-pressure chamber and inlet and outlet passages. A rotatable piston is mounted in the casing, composed of two hollow semi-cylindrical portions, and two end-portions having semi-circular projections forming transverse channels on their inner faces adapted to receive and guide the blade-mechanism. Two reciprocating blades are movably mounted in the rotating piston, while a cylinder and piston on the inner end of each of the blades have communication with the fluid-pressure chamber of the casing, so that fluid-pressure may operate the blade-pistons. Spring mechanism is inserted between the blade-pistons to hold the same apart.

591,029.—Compressed Air Water Elevator. Paul S. A. Bickel, Helena, Mont.

Two similar air-tight vessels are provided each with an inlet for the liquid only, the latter being controlled by a valve which opens as the vessel is lowered in the liquid, and closes as it rises therein. An outlet for the liquid only is controlled by a valve which is closed when the vessel is lowered and opened when the vessel is raised. By means of air under pressure the liquid is released as the vessel is raised.

592,116.—Pneumatic Hammer. C. H. Johnson, Springfield, Ill.; assignor of one-half to W. B. Ridgeley, same place.

A casing is provided with a longitudinal bore and fluid-pressure inlets and outlets. A reciprocating piston-hammer is arranged in one end of the bore and has a headed inner portion to provide a constant fluid-pressure chamber which communicates with the fluid-pressure inlet and a longitudinal passage to alternately admit pressure to, and exhaust it from, the rear of the hammer. A reciprocating counter-balancing plunger is arranged end to end with the hammer and is formed with an inner headed portion to provide an annular pressure-chamber. This plunger is also provided with a longitudinal passage for admitting and exhausting pressure to and from the space between itself and the hammer. The chamber and passage are arranged to be alternately connected and disconnected with the pressure inlet.

The Artist of the N. Y. Journal makes a sketch of the Batcheller Pneumatic Apparatus.
N. Y. Journal, October 8, 1897.

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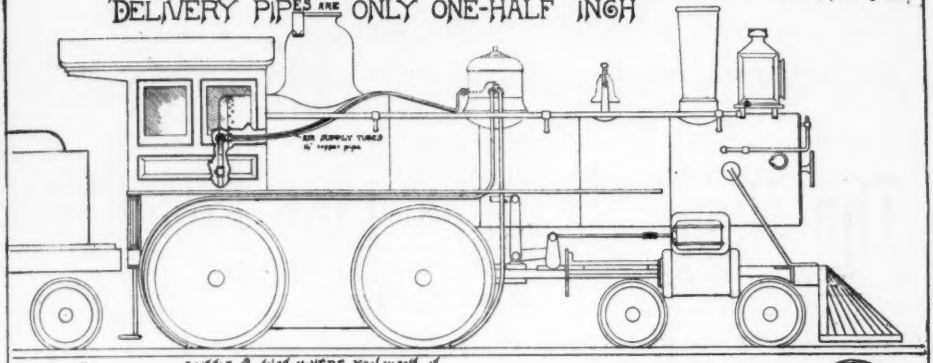

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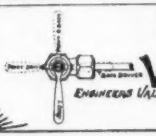

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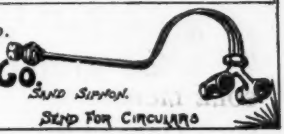

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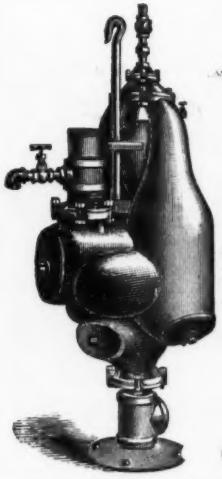

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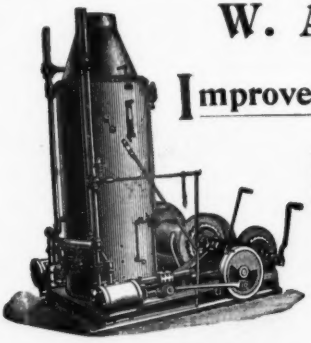

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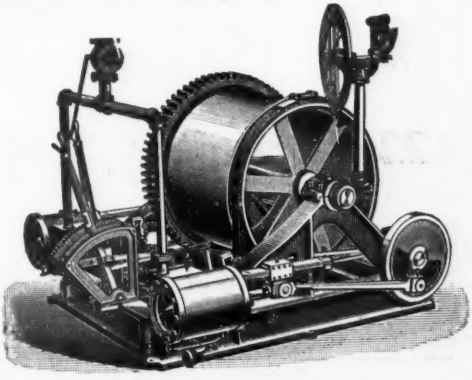

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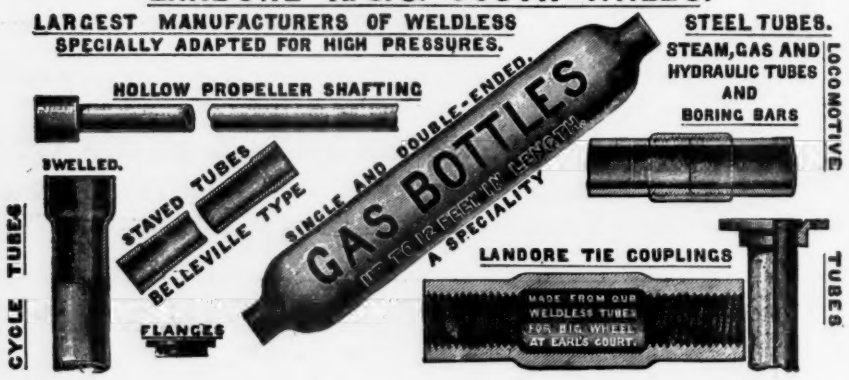

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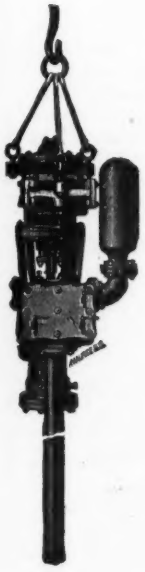

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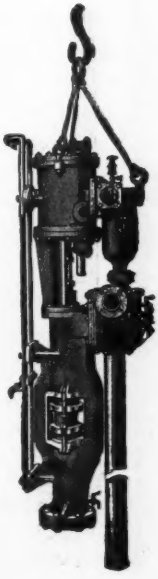

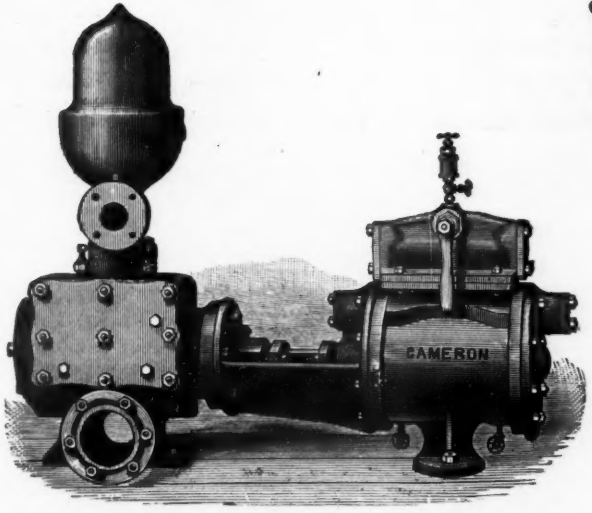

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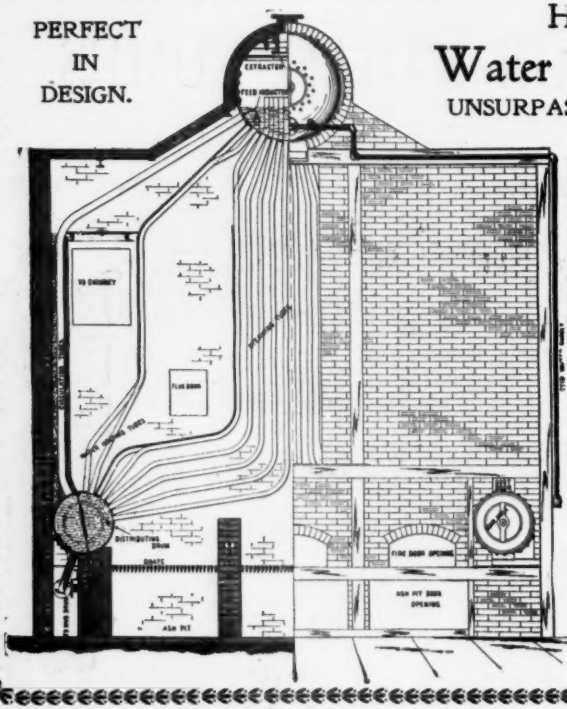

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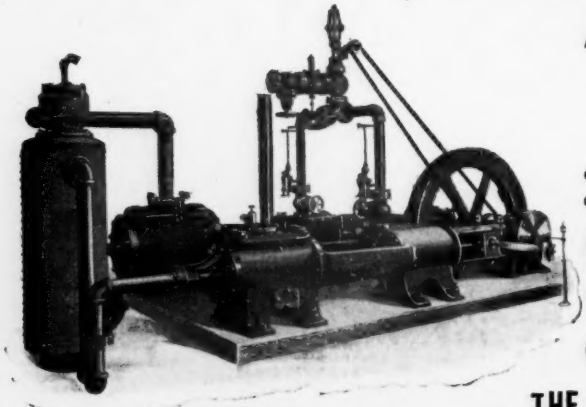

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